Jurnal Akademika Kimia, 10(3): 182-187, August 2021
ISSN (online) 2477-5185 | ISSN (print) 2302-6030
http://jurnal.fkip.untad.ac.id/index.php/jak/

OPEN ACCESS

Determination of Vitamin C and Metal Copper (Cu) Levels in Katokkon Chili (Capsicum chinense Jacq) Based on Maturity Level

***Novianti Patiung, Daud K. Walanda & Sitti Aminah**
Program Studi Pendidikan Kimia/FKIP – Universitas Tadulako, Palu – Indonesia 94119

Received 23 June 2021, Revised 22 July 2021, Accepted 18 August 2021
doi: 10.22487/j24775185.2021.v10.i3.pp182-187

Abstract

Katokkon chili is one type of chili grown mainly in the Tana Toraja district, and the people use this plant as a typical spice with variations colors from green, orange, and red. It is assumed that the plant is rich in vitamins and minerals. This study aims to determine the levels of vitamin C and copper metals in katokkon chili based on their level of maturity. Vitamin C and copper levels were determined by spectrophotometry. The results showed that the highest level of vitamin C was 23.52 and 5.12 mg/kg in both wet and dry orange chilies, while the highest copper level was found in green chili was 12.25 mg/kg.

Keywords: Katokkon, chili, vitamin C, copper, spectrophotometry

Introduction

Chili is a widely developed type of plant in the food industry because chili is usually used for cooking spices. Besides being a food ingredient, chili is also commonly used in the pharmaceutical industry because extracts from chili peppers have many properties, including a thrush drug, tonic, a potent stimulant for the heart and blood flow antirheumatic, anticoagulant, stomachic, carminative, diaphoretic, and diuretic. Chili in Indonesia can be classified into three species, each with the name big chili (Capsicum annuum L.), cayenne pepper (Capsicum frustescens L), and sweet chili (Capsicum longum L) (Hartiningsih & Sunarjono, 1976).

One type of chili in Indonesia with high economic potential but has not been widely explored and identified is the katokkon chili variety (Capsicum chinense Jacq). Katokkon chili is a local variety of Toraja and the commodity most in demand by the people around Tana Toraja Regency because of its distinctive aroma and spicy taste. Chili katokkon can develop business and industrial processed ingredients such as sauce and chili powder. This plant grows well in the tropics and is widely cultivated in the highlands of Tana-Toraja and Enrekang districts, South Sulawesi (Warisno & Dahana, 2010).

Katokkon chili is a type of large chili (Capsicum annuum L.) which can generally be grown in the lowlands to highlands (mountains) ± 2000 meters above sea level (Flowrenzhy & Harijati, 2017; Mutmainnah & Masluki, 2017). Based on statistical data on vegetable and fruit crops, the productivity of katokkon chili in Tanah Toraja in 2006 was 2.87 tons/ha, and in 2007 it increased to 3.3 tons/ha. Katokkon chili has a characteristic, namely the shape of the fruit is short, fat, and blunt, the average size is (3-4) cm long, and the cross-section is (2-3½) cm wide, similar to paprika chili, only smaller in length with a distinctive aroma and spicy taste. Young fruit is green; ripe fruit is bright red, while half-ripe fruit is orange. The fruit's skin is thick, the flesh is empty, and the seeds are not as many as red chili seeds (Mutmainnah & Masluki, 2017).

In general, chili has a lot of nutritional content or chemical compounds; each type will be different, including calories, protein, fat, carbohydrates, minerals, vitamins, and water. Minerals Cu and vitamin C are chemical compounds that have an essential role in the body (Setiadi, 1993; Fantastico, 1996). However, especially for katokkon chili, the vitamin C and Cu minerals content has not been studied much.

Vitamins are complex compounds needed by the body that help regulate or regulate the body's metabolic processes. One of the vitamins required by the body is vitamin C. Vitamin C or ascorbic acid is a vitamin made from hexose derivatives that are soluble in water and easily oxidized. The process is accelerated by heat, light, alkali, enzymes, and copper and iron catalysts. According to Naidu

*Correspondence:
Novianti Patiung
e-mail: novipatiung2005@gmail.com

(2003), vitamin C is a water-soluble vitamin essential for collagen biosynthesis. The less vitamin C content when heated, the smaller the levels of vitamin C produced (Oktaviana et al., 2012). Vitamin C has many health benefits, one of which can form intercellular collagen (Winarno, 2008).

In addition to vitamin C, chili also contains the mineral Cu, which has a vital role for the body, especially for humans; however, it is needed in quite a small amount where the mineral Cu is an essential microelement for the body. Therefore it must always be present in the foodstuffs to be consumed (Ganiswara, 1995). Cu metal is one element in the chemical periodic table in group I B and period 4 with atomic number 29. Cu metal is quite commonly found in the Toraja area, a place for growing various types of plants, one of which is katokkon chili.

The level of maturity of chili will affect the quality of chili and the level of a compound contained in it. One of the maturity levels can be seen from the change in color where young chilies will be green, half-ripe chilies are orange, while ripe chilies will be bright red (Mutmainnah & Masluki, 2017).

Several characteristics affect the maturity level of katokkon chili, including color changes where color changes in fruit are caused by chlorophyll degradation. This process is followed by the biosynthesis of one or more other colors, both anthocyanins, and carotenoids (Philouze, 1991). In addition to color changes, there is also a change in aroma, where the riper the chili, the more intense the smell is produced. This change in smell is caused or associated with the content of phenols and tannins, which is related to the sugar and acid content in the fruit (Ulrich, 1970; Whiting, 1970). According to Keegstra et al. (1973), the ripening process of chili will also result in changes in the texture of the fruit itself. Changes in the cell wall or surface of the fruit are determined by the cellulose and pectin content.

This paper is intended to describe the levels of vitamin C and copper metal (Cu) in katokkon chili based on the level of maturity.

Methods

The tools used in this research are analytical balance, dropper pipette, measuring cup, beaker, measuring flask, stirring rod, spatula, volume pipette, porcelain cup, funnel, spray bottle, a set of simple reflux tools, blender, oven, magnetic stirrer, UV-Vis spectrophotometer (Genesys 10 UV), and Atomic absorption spectrophotometer (AAS) Spectra AA 932.

The ingredients used in this study were katokkon chilies (green, orange, and red) originating from Toraja, aquades, Cu solids (*Merck*), 65 % HNO_3 (*Merck*), 96 % H_2SO_4 (*Merck*), and standard vitamin C (*Merck*). ascorbic acid), filter paper and aluminum foil.

Sample preparation

Chili katokkon based on the level of ripeness clean cut into small pieces. To determine vitamin C levels, two types of samples were used, namely wet samples and dry samples, while for the determination of copper metal content, only dry samples were used. The dried pieces were mashed using a blender until they became powder. As for the wet sample, it was smashed directly using a blender until the sample was smooth. To determine the Cu content, first, the clean chilies were dried. Then each fruit was weighed based on the level of maturity as much as 250 grams, then cut into small pieces and continued with drying using an oven at a temperature of 100-105 °C for ± 6 hours until the weight was obtained. Permanent. The next step is that the dry sample is mashed using a blender to get a piece in powder form.

Vitamin C analysis

Standard solution

50 mg of ascorbic acid was put into a 500 mL volumetric flask and dissolved with distilled water to the mark.

Determination of λ_{max} vitamin C

1 mL of 100 ppm vitamin C solution was put into a 50 mL volumetric flask (concentration two ppm), and then clarified water was added to the mark. Next, measure the absorption at a 200-300 nm wavelength using a blank with distilled water (Badriyah & Manggara, 2015).

Calibration curve

100 ppm vitamin C solution was put into a 50 mL volumetric flask as 2, 4, 6.8, and 10 mL (4, 8, 12, 16, and 20 ppm, respectively). Then add distilled water up to the mark and then homogenize. Furthermore, the absorption is measured at the maximum wavelength obtained (Badriyah & Manggara, 2015).

The steps taken for wet and dry samples are the same: the first 10 grams of the prepared sample are weighed and then put into a beaker. Furthermore, it is added with sufficient distilled water and stirred until evenly mixed and filtered. The filtered filtrate is put into a 100 mL volumetric flask and added to the measuring limit with distilled water. The next step is to put 2 ml of the solution into a 100 mL volumetric flask, add distilled water to the measuring limit. After that, measure the absorbance of the sample at a wavelength of 220 nm.

Copper (Cu) analysis

Standard solution

1 gram of solid Cu was weighed and then dissolved with 50 mL of 5 M HNO_3 in a 100 mL measuring cup, then diluted with distilled water to the mark. Then put into a 1000 mL volumetric flask and adjust the volume to the pattern using distilled water.

Cu solution 10 ppm

It was made using 1 mL of 1000 ppm Cu standard solution was pipetted and put into a 100 mL volumetric flask, and added with distilled water up to the measuring limit.

Standard solution of Cu 0.05; 0.1; 0.5; 1 and 1.5 ppm were made by taking as much as 0.25; 0.5; 2.5; 5 and 7.5 mL of a standard solution of 10 ppm Cu and put into a 50 mL volumetric flask and then added with distilled water to the limit mark. Next, measure the absorbance of each standard using an atomic absorption spectrophotometer (AAS) at a wavelength of 324.7 nm.

1 gram of the prepared sample was put into a 250 mL boiling flask. A mixture of 5 M HNO_3: 5 M H_2SO_4 has added as much as 15 mL with a ratio of 2: 1 then heated at a temperature above 100 °C until a clear solution was obtained. After that, cool the solution at room temperature for a while, then filter using Whatman 42 filter paper. Furthermore, the purified filtrate is put into a 50 mL volumetric flask and added with 0.5 M HNO_3 to the measuring limit. After that, measure the absorbance of the sample using an atomic absorption spectrophotometer (AAS) at a wavelength of 324.7 (Taufikurrahman, 2016).

The data obtained from the measurement results are then graphed between absorbance and concentration where the absorbance value is on the "y" axis and the concentration on the "x" axis which will then be analyzed using a regression equation to obtain the levels of vitamin C and Cu metal in the sample with the following equation: y = ax + b.

Data analysis was carried out descriptively by displaying the laboratory analysis results and comparing the levels of vitamin C and Cu metal in katokkon chili based on the level of maturity.

$$Level = \frac{Concentration\ of\ reading\ x\ Vp\ x\ Fp}{Berat\ sampel}$$

where Vp is the determination volume and Fp is the dilution factor.

Results and Discussion

This study has two types of sample preparation for determining vitamin C levels, namely wet and dry samples, while for determining Cu levels using dry samples. It is done by drying using an oven at a specific temperature for dry samples. Then the dried pieces were made in powder form. The purpose of the sample is made in powder form to expand the powder's surface. The contact between the powder and the solvent is maximized, and the active substance content can be extracted optimally (Diniatik, 2015). As for the wet sample, use fresh chilies without going through a drying process which is then mashed with the same goal on dry samples, namely to expand the sample's surface to be analyzed.

Vitamin C levels

The results of calculating vitamin C levels obtained in katokkon chili can be seen in **Table 1**.

Table 1. Results of analysis of vitamin C levels (mg/kg)

No	Sample Type	Wet Sample	Dry Sample
1	Green Katokkon	16.88	3.45
2	Orange Katokkon	23.52	5.12
3	Red Katokkon	21.30	4.67

It can be seen from the results of the study that the levels of vitamin C in katokkon chilies were 16.88; 23.52, and 21.30 mg/kg for the wet sample while the dry sample was 3.45, respectively; 5;12; 4.67 mg/kg. From these data, it can be seen that vitamin C levels in a sample can be influenced by the maturity level of the sample and the type of sample treatment where the highest vitamin C levels are found in orange katokkon chili, then red and the last green for both wet and dry samples.

The results obtained showed an increase in vitamin C levels from green katokkon chilies to orange katokkon chilies. This is because the fruit is still in the process of development. In this process, there is an increase in vitamin C synthesis due to the L-gulonolactone oxidase enzyme in the fruit. Vitamin C in fruit is a secondary metabolite because it is formed from glucose via the D-glucuronic acid and L-gulonic acid pathway (Yan et al., 2007). It can also be seen in the table above that there was a decrease in vitamin C levels from orange katokkon chilies to red katokkon chilies. The reduction in vitamin C levels was due to an increase in the activity of the enzyme ascorbic acid oxidase which plays a role in overhauling vitamin C due to environmental influences. In this case, a decrease in vitamin C levels will occur when the maximum increase point has been exceeded (Santosa & Hulopi, 2008). The reaction to the overhaul of vitamin C is still happening but is running slowly, decreasing vitamin C levels. This means that enzymes that play a role in reshuffling vitamin C are still ongoing with the surrounding environmental conditions. In this process, there is an overhaul of vitamin C where ascorbic acid will be oxidized to dehydroascorbic acid, which still has activity as a vitamin which will then undergo further changes by hydrolysis to form L-diketogulonic acid, which has no activity as vitamin C, which causes vitamin C levels to decrease. Along with the age of the fruit. Noor (1992) emphasized that the intensity of the effect of the enzyme depends on the amount present in the material, the duration of its impact, and the working conditions of the enzyme. (Safaryani et al., 2007).

A decrease in vitamin C levels in fruit is because vitamin C is easily degraded, both by temperature, light, and the surrounding air so that vitamin C levels are reduced. The process of damage or decrease in vitamin C is called oxidation. The oxidation reaction is a reaction that releases electrons by a molecule, atom, or ion in a chemical reaction (Niswah et al., 2016). There are two kinds of oxidation reactions of vitamin C, namely, the spontaneous oxidation process and the non-spontaneous oxidation process. The spontaneous oxidation process is an oxidation process that occurs without the use of enzymes or catalysts. At the same time, the oxidation process is not automatic, namely the reaction that occurs with the addition of enzymes or catalysts, such as glutathione enzymes. This enzyme is a tripeptide consisting of glutamic acid, cysteine, and glycine (Andarwulan & Koswara, 1992).

Vitamin C can be formed as L-ascorbic acid and L-dehydroascorbic acid, both of which have activity as vitamin C. Ascorbic acid is very easily oxidized reversibly to L-dehydroascorbic acid. L-dehydroascorbic acid is chemically very labile and undergoes further changes to L-diketogulonic acid, with no vitamin C activity anymore. According to Nadeak & Susanti (2012), the higher the maturity level of the fruit, the water content, total dissolved solids, color value, and preference for fruit aroma and texture will increase. Still, the content of vitamin C, total acid, and hardness value will decrease. This can be seen from the results of the study, which showed that the highest levels of vitamin C were obtained in orange-colored fruit, which indicated that vitamin C levels in the fruit would increase until the fruit was ripe and would decrease when the level of maturity had been exceeded, which was marked by a decrease in vitamin C levels. on red fruit. Therefore, the content of vitamin C in fresh fruit can be used to indicate fruit maturity. Vitamin C levels in fresh fruit are influenced by the type of fruit, growing conditions, maturity level at harvest, and post-harvest handling (Winarno, 2008).

The results of research for vitamin C also show that in addition to the level of maturity, temperature also dramatically affects the levels of vitamin C in a food ingredient, and it can be seen from the very significant difference between wet samples and dry samples that have gone through the drying process using an oven. From these results, this figure is a number that can be said to be included in the fulfillment of nutritional adequacy in the body. According to Cakrawati & Mustika (2012), the nutritional adequacy of vitamin C for ages 0-6 months is 30 mg, ages 7-12 months is 35 mg, ages 1-3 years is 40 mg, and ages 4-9 years is 45 mg. As for the age group 10-12 years, 50 mg and age 13 years and over 60 mg. Based on the results of research and the number of nutritional adequacies needed in the body for vitamin C, it can be seen how much of this material must be consumed every day to meet nutritional adequacy in the body because a deficiency or excess of vitamin C will cause harm to the body.

Vitamin C plays a vital role in cell homeostasis, acting as a powerful antioxidant and a positive modulator of cell differentiation (Sandoval et al., 2013). Excess vitamin C can occur if a person takes supplements or a food ingredient that contains large amounts of vitamin C. Excessive accumulation of vitamin C in the body and insufficient fluid intake can cause kidney stones. Digestive tract disorders and destruction of red blood cells. Other consequences caused by a lack of vitamin C in the body are bleeding gums, joint pain, dry eyes, skin, difficult healing of wounds, and decreased white blood cell count (Cakrawati & Mustika, 2012).

Copper metal content (Cu)

The results of the calculation of copper (Cu) levels obtained in katokkon chili can be seen in **Table 2**.

Table 2. Results of analysis of Copper (Cu) content

No	Sample Type	Level Cu (mg/kg)
1	Green Katokkon	12.25
2	Orange Katokkon	9.75
3	Red Katokkon	8.50

Based on **Table 2** above, it can be seen that the levels of Cu metal in katokkon chilies at different maturity levels have different levels where the younger the chili, the higher the Cu content in the chili and vice versa. The levels obtained for green katokkon chili are 12.25 mg/kg; orange katokkon chili is 9.75 mg/kg, and red katokkon chili is 8.50 mg/kg. Copper metal contamination in katokkon chili can be caused by several factors, including planting media, fertilizers, air pollution, and water use. The transfer of metals from soil to plants depends on the soil's composition and pH or acidity. Plants can absorb metals in high soil fertility and high organic matter content. Metals will not dissolve in the soil if the soil is not too acidic. The soil's acidity can be caused by the high content of fertilizers and residual pesticides used to accelerate the growth process and reduce pest attacks on plants. According to Taufikurrahman (2016), NPK and TSP fertilizers contain heavy metals Cu and Zn, so the use of these fertilizers must be done in the right way. In addition, the metal content contained in katokkon chili is also influenced by the high levels of metals found in the Tana Toraja area (Sukmana et al., 2002).

From the results of the analysis that has been carried out, it can provide information that katokkon chili originating from Tana Toraja Regency is positive for Cu metal, with the average content value still below the threshold set by the Indonesian National Standards Agency (SNI), which is 30 mg/kg so that this chili is still very suitable for consumption by the general public considering the function of Cu metal in the body is also very necessary as a mineral that plays an essential role for health and the content of other compounds contained in katokkon chili.

Conclusions

Based on the research that has been done regarding the determination of the levels of vitamin C and metallic copper (Cu) in katokkon chili (Capsicum chinense Jacq) based on the level of maturity, it can be concluded that the levels of vitamin C in green, orange and red katokkon chilies are 16.88; 23.52 and 21.30 mg/kg for the wet sample and the dry sample were 3.45, respectively; 5.12 and 4.67 mg/kg. Meanwhile, the copper (Cu) levels in green, orange, and red katokkon chilies were 12.25, respectively; 9.75 and 8.50 mg/kg.

Acknowledgment

The authors would like to thank the laboratory assistants for Chemistry Education, Faculty of Teacher Training and Education, Tadulako University, laboratory health workers in the Palu area, and all parties who have helped the author complete this research.

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